Sorensen
A Raytheon Company

Instruction Manual for

Option M9A IEEE488 Interface

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Instruction Manual

Release 1.01

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OPTION M9A - IEEE 488 INTERFACE
GPIB OPERATION

Interface Functions

The following interface functions, defined by IEEE standard 488 are implemented:

SH1	(Source Handshake)
AH1	(Acceptor Handshake)
T6	(Talker)
L4	(Listener)
SR1	(Service Request)
RL1	(Remote Local)
PP1	(Parallel Poll)
DC1	(Device Clear)
DT1	(Device Trigger)
E1	(Open Collector Drivers)

Multiline Control Functions

The Acceptor Handshake, Source Handshake, Listener, and Talker functions are implemented by the interface card and the controller and require no action by the user. The ADR indicator led turns on when the power supply is addressed to listen or talk. (The talker function includes serial poll)

Service Request

Service request is a uniline message asserted by the power supply at power on and for fault conditions. Seven power supply conditions are defined as faults. Enabling or disabling a condition from asserting service request does not affect the condition within the power supply, nor external status indicators.

Device Clear

The power supply will implement Device Clear regardless of whether the unit is in local or remote control. Device Clear is typically used to send all or selected devices to a known state with a single command. The power supply will be set to Initial Conditions after Device Clear.

Device Trigger

Device Trigger will enable the most recently programmed values whether the unit is in local or remote control. If the power supply is in local mode, the new values will be implemented when switched from local to remote control. Device Trigger is typically used to synchronize the operation of a number of addressed devices.

Serial Poll

In a serial poll, the controller polls each device. The power supply responds with an 8 bit status byte defined as follows:

Bit Position	Decimal Weight	Description	Reset By
0 (LSB)	1	Fault - set when any bit in fault register is set	FAULT? query
1	2	Not Used	
2	4	Not Used	
3	8	Not Used	
4	16	Ready - set when power supply is ready to accept commands	Power supply, during command processing period
5	32	Error - set when ERR bit asserted in status register	ERR? query
6	64	Request Service - set when power supply requests service	Serial Poll
7 (MSB)	128	Power On - set when unit initializes at power on	CLR or Device Clear

Parallel Poll

Parallel poll allows the controller to determine quickly which of a number of instruments on the bus requested service. The parallel poll response corresponds to bit #7 of the serial poll status byte. Parallel poll does not reset the service request. The power supply must be configured remotely to respond to a parallel poll with either a "1" or "0" on one of the DIO lines if the unit is requesting service.

Remote/Local

The remote/local function allows the power supply to operate in either local or remote (IEEE 488) control. The power supply may be switched from REM to LOC and back to REM using the remote switch on the rear panel without loss of the programmed values. The user can send Local Lockout to the power supply via the IEEE 488 bus to disable the remote switch on the rear panel. With Local Lockout, the controller determines if the unit operates in local or remote mode. This enables the controller to prevent anyone from returning the power supply to local control.

Address Selection

The GPIB primary address switches are located on the rear panel. The GPIB address is set in binary, with A1 the least significant bit and A5 the most significant bit. Any address from 00 to 30 decimal is a valid GPIB address. The power supply address is the total value of switches selected. Setting switches to Address 31 will cause a self-test error.

Rear Panel Switch Detail

Switch #	Function	Open	Closed	
8	A5	0	16	Primary Address value
7	A4	0	8	is set by A1, A2, A3,
6	A3	0	4	A4, and A5
5	A2	0	2	
4	A1	0	1	
3	-	-	-	
2	PON SRQ	ON	OFF	
1	REMOTE	ON	OFF	

Internal Switch Detail

Switch #	XT/HPD Function	Open	Closed	DCS Function	
1	A1	1	0	A1	Secondary address
2	A2	2	0	A2	is set by A1, A2,
3	A3	4	0	A3	A3, A4, A5.
4	A4	8	0	A4	Default value 31
5	A5	16	0	A5	disables Secondary addressing.
6	Series Select	HPD	XT		Switches 6, 7, and 8
7	Program OVP	OFF	ON		on DCS, select model
8	Local OVP	OFF	ON		type. See table below.

For XT/HPD units, set only one of OVP switches 7 or 8 to avoid indeterminate OVP state. For programmed OVP, see OVSET command. For local OVP, use front panel OVP adjustment (see power supply manual for details).

DCS Model Selection

	Switch #			
Model #	6	7	8	
DCS 8 - 125	C	C	C	O = Open
DCS 20 - 50	O	C	C	C = Closed
DCS 40 - 25	C	O	C	
DCS 60 - 18	O	O	C	
DCS 80 - 13	C	C	O	
DCS 150 -7	O	C	O	
DCS 300 - 3.5	C	O	O	
DCS 600 - 1.7	O	O	O	

Power-On Service Request

The power supply will request service from the controller if the rear-panel PON SRQ switch is set and the power supply is turned on or any time a momentary input power dropout causes the power supply to re-initialize.
The power supply initializes at power on with the following programmed values:

Initial Conditions (Remote enabled)

		eg.XT30-2 defaults
Voltage	0 Volts	(VSET 0)
Current	0 Amps	(ISET 0)
OVP Trip Voltage	Model VMAX + 10%	(OVSET 33)
Soft Voltage Limit	VMAX (see models)	(VMAX 30)
Soft Current Limit	IMAX (see models)	(IMAX 2)
Delay	0.5 seconds	(DLY 0.5S)
Foldback Protection	off	(FOLD OFF)
Output	on	(OUT ON)
Unmask	none	(UNMASK NONE)
Hold	off	(HOLD OFF)
Service Request Capability	off	(SRQ OFF)

Programming Specifications (25 ± 5 ^{o}C)

	Program Resolution	Program Accuracy	Readback Resolution	Readback Accuracy
Voltage	± 0.03%	± 0.1%	± 0.03%	± 0.1%
Current	± 0.03%	± 0.1%	± 0.03%	± 0.1%
OVP	± 0.05%	± 0.2%	-	-

Auxiliary Connector J7 (rear panel)

J7-1	External TTL shutdown signal
J7-2	Polarity signal, open collector (asserted by VSET -x)
J7-3	Isolation signal, open collector (asserted by OUT OFF)
J7-4	Fault signal, open collector (asserted when bit set in FAULT register)
J7-5	external VCC, 18 V maximum
J7-6	external GND and shutdown return

Programming Syntax

Lower-case alpha characters sent to the power supply are treated as upper-case alpha characters.

Numbers can be sent to the power supply with implicit or explicit decimal point or in scientific notation.

eg. implicit - 475, 005, 2 (integers)
explicit - 14.4, 0.075, 1.
scientific - 144 E -1, -5 e 0, 23 E 2

In scientific notation the letter "E" stands for "10 raised to the power of". All numeric data fields may contain an optional plus or minus sign on both the number itself and the exponent.

At least one digit must precede E. Lower case e is treated the same as upper case E.

All numeric data fields may contain leading spaces, and embedded spaces between signs and digits, digits and E, decimal point and E, and E and sign.

eg. 1.23 E + 4 same as 1.23E+4
+ 123. E + 4

Embedded spaces will not be accepted between digits or between digits and decimal point.

Separators are used by the power supply to break up commands. The explicit separators are commas and spaces.

Spaces are used in all commands containing only one parameter. Any number of consecutive spaces is treated as one space.

eg. OUT ON - correct
OUTON - wrong

Commas are used only to separate parameters in commands containing more than one parameter. MASK and UNMASK are the only commands for which more than one parameter may be sent. Only one comma is allowed, and it may be preceded or followed by any number of spaces.

eg. MASK CV,OVP,FOLD
MASK CV, OVP, FOLD
MASK CV , OVP , FOLD

Terminators mark the end of a command string, and inform the power supply to execute the command. The termination characters are the line feed and semicolon.

Line feed is sent by most controllers automatically with OUTPUT statements. If more than one command per line is sent, the commands must be separated by semicolons.

A terminator may be preceded or followed by any number of spaces.

eg. ISET 2.0A;VSET 5V or
ISET 2.0A ; VSET 5V

The carriage return character by itself will be accepted without error in all cases where a terminator is expected.

Commands may also be terminated by asserting EOI on the GPIB concurrently with the last byte of the command.

eg. VMAX 5.25
E
O
I

All data sent by the power supply to the controller is terminated by a carriage return and a line feed character. EOI is asserted concurrently with linefeed.

eg. VOUT 5.250CRLF
E
O
I

Device Dependent Command Descriptions

VSET x
VSET xV
VSET xmV
VSET -x

Programs the output voltage in volts or millivolts. The programmed voltage is the actual output in CV mode or the voltage limit in CC mode. A negative value sets the Polarity line J7-2 on the rear panel which may be used to trigger external relays to switch the output polarity.

Range x = 0 to Model VMAX.
Initial value = 0 Volts

VSET?

Queries the voltage setting and returns the value to the GPIB when addressed to talk.

Response VSET ddd.ddd or
VSET -ddd.ddd

VOUT?

Measures the actual voltage output and returns the value to the GPIB when addressed to talk.

Response VOUT ddd.ddd

VMAX x
VMAXxV
VMAX xmV

Programs an upper soft limit on the voltage programming value that the power supply will accept. If the soft limit is exceeded, or if the soft limit value is lower than the present output values, the supply will ignore the command, turn on the ERROR led, and set the ERR bit in the status and serial poll registers.

Range x = 0 to Model VMAX
Initial = Model VMAX

VMAX?

Queries the soft voltage limit setting and returns the value to the GPIB when addressed to talk.

Response VMAX ddd.ddd

ISET x
ISET xA
ISET xmA

Programs the output current in amps or milliamps. The programmed current is the actual output in CC mode or the current limit in CV mode.

Range x = 0 to Model IMAX, Initial = 0 Amps

ISET?

Queries the current setting and returns the value to the GPIB when addressed to talk.

Response ISET ddd.ddd

IOUT?	Measures the actual current output and returns the value to the GPIB when addressed to talk. Response IOUT ddd.ddd
IMAX x IMAX xA IMAX xmA	Programs an upper soft limit on the current programming value that the power supply will accept. If the soft limit is exceeded, or if the soft limit value is lower than the present output values, the supply will ignore the command, turn on the ERROR led, and set the ERR bit in the status and serial poll registers. Range x = 0 to Model IMAX Initial = Model IMAX
IMAX?	Queries the soft current limit setting and returns the value to the GPIB when addressed to talk. Response IMAX ddd.ddd
OVSET x OVSET xV OVSET xmV	Programs the over voltage protection trip point in volts or millivolts. Range x = 0 to 110% * Model VMAX Initial= 110% * Model VMAX
OVSET?	Queries the OVP setting and returns the value to the GPIB when addressed to talk. Response OVSET ddd.ddd
DLY x DLY xS DLY xmS	Programs the delay time after a new output voltage or current is implemented (VSET, ISET), or RST, T, TRG, or OUT ON command is received. During delay time, the power supply disables CV, CC, and FOLD from generating faults. This command is useful to avoid nuisance foldback or service requests that may be generated by CV, CC, or FOLD should the power supply momentarily switch modes while implementing a new output. Delay may be used in these cases to avoid unnecessary service requests. Bits in the status and accumulated status registers continue to be set and are not affected by the delay command. Range x = 0 to 32 seconds, with 32mS resolution Initial = 0.5 Second

DLY?	Queries the delay setting and returns the value to the GPIB when addressed to talk. Response DLY dd.ddd
OUT ON OUT 1 OUT OFF OUT 0	Enables or disables power supply output. The power supply will continue to implement new commands while output is disabled. OUT OFF or OUT 0 also set the Isolation line J7-3 on the rear panel which may be used to trigger external relays to isolate the power supply from the load. Initial = OUT ON
OUT?	Queries the output on/off setting and returns the value to the GPIB when addressed to talk. Response OUT 0 or OUT 1
FOLD CV FOLD 1 FOLD CC FOLD 2 FOLD OFF FOLD 0	Enables or disables foldback protection, which will disable the power supply when the output enters the fold condition. eg. FOLD CV means the power supply should operate in CC mode, and foldback protection will turn off the output if the supply switches to CV mode. Foldback protection is disabled during delay time. Initial = FOLD OFF
FOLD?	Queries the foldback setting and returns the value to the GPIB when addressed to talk. Response FOLD 0 or FOLD 1 or FOLD 2
RST	Resets power supply to present voltage and current settings if output is disabled by OVP or foldback protection. Output values may be changed while unit is disabled.
HOLD ON HOLD 1 HOLD OFF HOLD 0	Holds voltage and current setting values for later implementation when ON or implements immediately upon receipt when OFF. Held values are implemented with T, TRG or device trigger interface command allowing synchronization of multiple GPIB instruments. Initial = HOLD OFF

HOLD?	Queries the hold setting and returns the value to the GPIB when addressed to talk. Response HOLD 0 or HOLD 1
T TRG	Implements voltage and current setting values that have been sent and held by the power supply. The power supply will operate with previous values until the trigger command is sent (see HOLD). The device trigger interface message performs the same function.
CLR	Initializes the power supply to power on state and resets the PON bit in the serial poll register. The device clear interface message performs the same function.
ERR?	Queries the error detected and returns the value to the GPIB when addressed to talk. When the power supply detects a programming error it sets the ERR bit in the status register, which can be unmasked to request service. Additionally, the remaining portion of the command line is discarded. The error value is valid only while the ERR led on the rear panel is lit. Error query or a new error free command clears the ERR bit in both the status register and the serial poll register. Response ERR x (see error codes)
ID?	Queries the power supply model number and firmware version and returns the value to the GPIB when addressed to talk. Response ID mmmmmmmmmm Version x.xxX eg. ID XT120-0.5 Version 1.02 ID HPD30-10 Version 1.02 ID DCS600-1.7 Version 1.02X

STS?

Queries the contents of the power supply's 8-bit status register that reflects the present state of the unit. Each of the eight bits represents a separate condition. When the condition is true, the corresponding bit is 1. Bits remain set in the status register as long as the corresponding conditions are true. See the register table below for a description of each bit in the status register, and the bit weight for each condition.

Response STS ddd

eg. If bits for OTP(16), OVP(8) and CC(2) are set, the power supply would send 26 (16+8+2) for ddd

STS, ASTS, MASK and FAULT register

Condition/ Mnemonics	ERR	FOLD	SD	OTP	OV	-	CC	CV
Bit Position	7	6	5	4	3	2	1	0
Bit Weight	128	64	32	16	8	4	2	1

ERR Remote programming error
FOLD Foldback protection tripped
SD External shutdown active (J7-1)
OTP Over temperature protection tripped (DCS only)
OV Over voltage protection tripped
- Not used
CC Constant current mode
CV Constant voltage mode

ASTS?

Queries the contents of the accumulated status register, which stores any bit that was entered in the status register since the accumulated status register was last read, regardless of whether the condition still exists. Reading the status register provides the controller only the state of the power supply at the time STS? was received. A condition that lasts only momentarily may not be observed even with frequent polling of the status register. To ensure that a temporary change can be noted by the controller, the power supply maintains an accumulated status register. The register table above describes this register as well as the status register. A bit in the register will be 1 if the corresponding bit in the status register has been 1 at any time since the register was last read.

Response ASTS ddd

UNMASK x
UNMASK mnemonics

Enables selected conditions to set bits in the FAULT register. Conditions can be enabled either by sending a string of mnemonics or by sending the decimal equivalent of the total bit weight for all conditions enabled. The mnemonics and the bit weights are the same as in the status register. Mnemonics are separated from each other by commas, and may be sent in any order. A bit is set in the fault register when the corresponding bit in the status register changes from 0 to 1 and the corresponding bit in the mask register is 1. Whenever any bit is set in the fault register the FAU bit is set in the serial poll register.

Range x = 0 to 255
Mnemonics = CV, CC, OV, OT, SD FOLD, ERR, NONE, ALL
Initial = UNMASK NONE

MASK x
MASK mnemonics

Disables selected conditions from setting bits in the FAULT register. Conditions can be disabled either by sending a string of mnemonics or by sending the decimal equivalent of the total bit weight for all conditions disabled. The mnemonics and the bit weights are the same as in the status register. Mnemonics are separated from each other by commas, and may be sent in any order.

Range x = 0 to 255
Mnemonics = CV, CC, OV, OT, SD, FOLD, ERR, NONE, ALL

eg. UNMASK ERR, CC (enables ERR and CC)
UNMASK OV (ERR, CC and OV enabled now)
UNMASK 1 (ERR, CC, OV and CV enabled now)
MASK ERR, CC (only CV and OV enabled now)
MASK 8 (only CV enabled)

Note UNMASK NONE = MASK ALL
MASK NONE = UNMASK ALL

UNMASK?

Queries the mask register to determine which bits have been selected to set faults and returns the value to the GPIB when addressed to talk.

Response UNMASK ddd

FAULT?

Queries the fault register to determine which bits have been set and returns the value to the GPIB when addressed to talk. A bit in the fault register is set when the corresponding bit in the status register changes from inactive to active and the corresponding bit in the mask register is set. Additionally, when a bit is set in the fault register, the Fault line J7-4 (rear panel) is also asserted. The fault line from any power supply in a system may be tied to the external shutdown line J7-1 of all power supplies to provide shutdown of the system independent of the GPIB for user defined faults. Bits in the fault register and the fault line are cleared only after the register is read by the FAULT? query.

Response FAULT ddd

SRQ OFF
SRQ 0
SRQ ON
SRQ 1

Disables or enables the power supply's ability to request service from the controller for fault conditions. The service request function allows use of either polling or interrupt programming. With SRQ on, the SRQ line will be asserted true whenever the FAU bit in the serial poll register changes from O to 1. Therefore, the mask register in addition to specifying which conditions set the FAU bit, also determines which conditions can generate service requests. Use of the FAULT? query will tell the user which condition caused the service request (except for PON). SRQ remains disabled until the FAU bit in the serial poll register is cleared by a FAULT? query.

Initial = SRQ OFF

SRQ?

Queries the SRQ setting and returns the value to the GPIB when addressed to talk.

Response SRQ 0 or SRQ 1

Error Codes

Error #	
0	No Errors
1	Unrecognized Character - A character like "!" was received.
2	Improper Number - A numeric character (+ -.0...9) was received but the characters did not represent a proper number. eg. +-5 V
3	Unrecognized String - An invalid command was received. eg. MASKERR
4	Syntax Error - A word, number, terminator, or separator was incorrectly placed. eg. OFF SRQ, IOUT 5A, MASK,ERR
5	Number Out Of Range - A number was received that is too large for the command with which it was received. eg. IMAX 999A, DLY 35S
6	Attempt to Exceed Soft Limits - An attempt was made to program a voltage or current greater than the soft limit. eg. VMAX 500V ; VSET 550V
7	Improper Soft Limit - An attempt was made to program a soft limit less than the output value.
8	Data Requested Without A Query Being Sent - A query command must precede each request for data by the controller. If the controller requests data from the power supply without first having sent a query, error 8 will result.
9	OVP set below output - An OVSET command was sent with a trip value lower than the output voltage.

Calibration

CALIBRATION COMPONENT	DCS	XT/HPD	PARAMETER AFFECTED
VADJ	R51	R65	Voltage Programming full scale level - Iterative with VOFF
VOFF	R28	R57	Voltage Programming offset - Adjust at 5% of full scale output voltage for best linearity - Iterative with VADJ
IADJ	R47	R60	Current Programming full scale level - Iterative with IOFF
IOFF	R27	R56	Current Programming offset - Adjust at 5% of full scale output current for best linearity - Iterative with IADJ
VGAIN	R49	R64	Voltage read-back full scale level - Iterative with VZERO
VZERO	R50	R37	Voltage read-back offset - Adjust at 5% of full scale output voltage for best linearity - Iterative with VGAIN
IGAIN	R45	R61	Current read-back full scale level - Iterative with IZERO
IZERO	R38	R58	Current read-back offset - Adjust at 5% of full scale output current for best linearity - Iterative with IGAIN
OVPREF	R19	R21	Overvoltage programming full scale level
OVPOFF	R23	N/A	Overvoltage programming offset - DCS only

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